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ABSTRACT

An institutional research project undertaken at Arizona State University to review the graduate curriculum in statistics and research methods is described. The research investigated the following: the needs for quantitative research skills in various degree programs; departmental requirements for research courses; the enrollment in graduate programs in the College of Education in Fall 1978; enrollment in specific research and statistics courses; and the extent to which each of the research skills was emphasized in the research courses. The investigation enabled description of course content, comparison of different instructors of the same course, and comparison of different courses. Guidelines for an appropriate College of Education sequence in research, measurement, and statistics were formulated based on an evaluation of courses content or objectives and the needs of graduate students. An inventory of research skills, which is appended, was developed. The inventory, which provided a framework for the instructional development process, included 72 skills, classified within the following general categories: formulating research problems, designing and conducting investigations, analyzing data, and interpreting results and presenting information. Information on required quantitative courses and the instructional emphasis placed on research in selected quantitative methods courses are presented. (SW)

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Evaluation of Graduate Research Training
in a College of Education

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Evaluation of Graduate Research Training in a College of Education

During the past several decades graduate training of students in colleges of education has undergone major changes. For example, foreign language requirements were eliminated in many schools. Additionally, cross-disciplinary core courses have, in many universities, been replaced by more flexible requirements involving options for students. The one academic domain that has steadfastly maintained its traditional form, however, is the area of quantitative research methods. Statistics and research methods courses have changed little during the past several decades. Nevertheless, advocates of ethnographic and other qualitative research methods are now challenging the once sacred traditions of Galton, Fischer, Thurstone, and Pearson. Graduate students and faculty are now asking whether statistical skills are actually needed for effective performance in their professional roles. Indeed, an increasing number of scholars are questioning whether classical statistical methods are an aid or a hindrance to educational innovation and development of new theories and concepts.

This is the context which gave rise to a review of the graduate research curriculum in the College of Education at Arizona State University. Our purpose, however, is not merely to describe the results of our efforts, but rather to generalize from our experience. Therefore, this report discusses how systematic data may be used for evaluation of research training in a graduate school of education. We will discuss issues that arise in evaluation of a research curriculum, and suggest types of data that could be used to formulate recommendations and guidelines for curriculum revision and instructional improvement. In addition, we will present illustrative instruments and data that were used by the Ad Hoc Research Curriculum Committee of Arizona State University. Our presentation is intended to

facilitate extension and application of the procedures to other institutions considering reviewing their research requirements.

Curriculum may be evaluated from a number of differing perspectives. The four component evaluation model proposed by Stufflebeam encompasses evaluation of the context, the inputs, the processes, and the products of a program. Emphasis on one or another of these components depends, of course, on the purpose and motives for the evaluation. For example, if the motivation for an evaluation study emanates from problems with curriculum structure, disagreements about educational goals and objectives, or allegations that certain needs are not adequately considered, then evaluation of the context for the curriculum should be considered first. On the other hand, if the motivation for evaluation grows primarily out of concern with poor products, rather than curriculum structure or goals, then evaluation of the staff, instructional effectiveness, and/or student performance should be emphasized. Since faculty at ASU held disparate views concerning the need for statistical training for graduate students, our study focused on the context and needs for statistical training in the graduate programs.

Curriculum Review at Arizona State University

The context in which ASU undertook a review and investigation of its graduate curriculum in statistics and research methods was as follows: The quantitative courses, though generally reputed to be rigorous and thorough, had been subjected to continuing criticism concerning their relevance. Faculty and students often complained they did not acquire practice in applying statistical skills. Furthermore, some students revealed lack of skills and understanding of statistical methods in their dissertations and oral examinations, despite having passed advanced statistics courses. Several departments had submitted proposals to modify or eliminate requirements for quantitative research courses. Some Departments sought to substitute their own courses for the traditional interdepartmental courses.

Accordingly, the Dean of the College appointed an ad hoc research committee to "establish guidelines for an appropriate COE sequence in research, measurement, and statistics. . . for all graduate programs in the college."

Analysis of this task indicated that confusion and lack of clarity may result from the tendency to view research requirements for various degree programs in terms of courses that are taught, without specific knowledge of course content or objectives; or, equally important, of what content ought to be taught, i.e., in terms of the needs of the graduate students. Therefore, the Research Curriculum Committee formulated the following questions as bases for recommending guidelines for research preparation:

1. What measurement, research, design, and other quantitative competencies are needed by graduate students in the differing departmental degree programs of the College of Education?
2. What is the approximate number of students that require these competencies?
3. What courses are currently being used to satisfy these competencies? How well are these courses serving their intended objectives?
4. What competencies do students currently completing degree programs say they possess?

The investigators recognized that students in various programs may need certain nonquantitative research skills, as well as quantitative skills. However, for practical reasons, the committee delimited the scope of the investigation by omitting skills in ethnography, content analyses, historical research, and other methodological approaches that do not rely heavily on inferential statistics. We did, nevertheless, include a general survey of needs for these skills, and efforts have been initiated to plan and develop curriculum in these areas.

Taxonomy of Research Competencies

Our initial efforts to identify needs for quantitative research skills met with some frustration, as our review of research did not reveal any taxonomy or inventory of research skills that should be included in a graduate curriculum. Accordingly, the committee developed such an inventory through a review of course

syllabi, textbooks, and related research. The final version of the instrument was comprised of 72 skills, classified within the following general categories:

- A. Formulating Research Problems
- B. Designing and Conducting Investigations
- C. Analyzing Data
- D. Interpreting Results and Presenting Information

This inventory of research skills comprised the contents of the two main instruments developed by the committee. The inventory, as incorporated into instruments, is presented in Appendix A.

The comprehensive compilation of research skills needed by students, even without regard to the survey data that were actually gathered, may be regarded as an important, perhaps essential, ingredient for program development. Research training can be planned and conceptualized in terms of skills that are needed by the graduates, rather than simply requiring courses. An inventory of relevant skills can provide a basis for formulating the objectives of the training program, on the one hand, and as criteria against which the program may be evaluated, on the other. Thus, the inventory of research skills provided us with a substantive framework for the instructional development process.

Evaluation of the Context for Curriculum Change

A process of curriculum development should properly begin with description and analysis of the context in which changes are to be instituted. An analysis of the context might consider issues such as the formal structure of the curriculum, patterns of enrollment in the existing courses, objectives of courses in the existing research curriculum, the level of satisfaction or dissatisfaction of various constituents with the existing curriculum and courses, and the perception of needs for research skills. The Ad Hoc Research Curriculum Committee considered several of these matters formally, gathering systematic data and conducting empirical investigation concerning the issues. Other matters were considered informally.

Study 1: Description of the Existing Curriculum Structure. In order to clarify the current policies, regulations, and practices concerning research training, the committee compiled the following information from institutional records:

- Current departmental requirements for quantitative previous semesters.
- Student enrollment in degree programs during previous semesters.
- Student enrollment in research courses during previous semesters.
- An induced course load matrix of course enrollment by department and degree programs.

Table 1 presents an overview of departmental requirements for research courses. This matrix depicts the structure of requirements for all research courses that are required across departments. Eight departments in the College offer graduate degrees, and they all require methods courses for their students.

Four departments: Educational Administration, Educational Psychology, Educational Technology, and Secondary Education, provide research courses that are used by other departments to meet research course requirements. Table 1 lists the fifteen research courses from the four departments that are taken by graduate students from at least one other department to meet their research requirements. Research Methods (EDF 500) and Introductory Statistics (EDP 454) reveal extensive cross-departmental relationships for M.A. programs. Inferential and multivariate statistics courses (EDP 552 and 554) reveal such relationships for doctoral programs.

Table 2 summarizes the enrollment in College of Education graduate programs in Fall, 1978. These enrollments represent "headcounts" including part-time, as well as full-time students. These figures are significant in that they represent one index of the general demand for research training in degree programs within each department.

Table 3a indicates the number of students enrolled in EDF 500 in Spring and Fall semesters of 1978. The significance of these figures lies in their representation of the overall demand for this particular research course. The data also show the degree levels and department of origin of the students enrolled in the EDF 500 class. Comparable tables were prepared for all research classes.

Table 4 presents essentially the same data as Tables 3a, etc., but they are classified by degree levels within departmental categories. Thus, the Table facilitates intra- and inter-departmental comparisons across degree programs. In addition, the Table represents the total enrollment in quantitative research classes for each degree program within each department. These data also describe patterns of enrollment in research courses for each department. In comparison with the headcount enrollments in Table 2, they represent an alternative index of demand for research training within each degree program.

Although the actual results in these tables are of interest primarily within the institutional context in which the data were generated, these tables are useful as models for presenting enrollment data in relation to curriculum analysis and development. For example, considered along with the instructor's reports of instructional emphasis (see following papers) they portray the scope of influence of courses upon students in various programs. Moreover, by depicting the range of degree levels and departmental origins of students enrolled in the classes, they characterize the representative student populations in the courses. Characteristics of these typical populations, in turn, presumably have a significant bearing upon the orientation, emphasis, and depth of instruction in the courses. Such data may be especially useful if the strategy for instructional development involves modification of existing courses, rather than formation of entirely new courses.

Study 2. Assessment of Current Instructional Practices. Having considered documentation of the enrollment patterns in research and statistics courses, a second issue concerns determination of the contents of the courses. The contents of the courses were assessed in terms of the Inventory of Research Skills (Appendix A). In order to establish which of the 72 research skills were taught in each research course, each instructor was asked to indicate the extent to which each of the research skills was emphasized in the research course he or she taught.

Specifically, the objectives of this study were to:

1. Assess the instructional emphasis each instructor placed on the research skills in the quantitative methods courses.
2. Assess the extent of inter-instructor variability for all courses taught by more than one instructor.
3. Develop a course profile for each quantitative methods course, describing the emphasis placed on each skill within the course.
4. Provide detailed data about all courses enabling each department to decide which quantitative methods courses could be selected to develop skills needed by students in the department's programs.

Initially, the Research Curriculum Committee examined course syllabi to determine whether the current research courses offered instruction related to the various skills that were identified as important for graduate students. However, the lack of specificity and uniformity among the syllabi precluded coherent assessment and interpretation of current instructional emphases. Therefore, the present study was designed to systematically assess the contents of the courses, as reported by the instructors, in terms of the 72 skills in the Taxonomy. To be sure, instructors' reports of their teaching emphasis should not be necessarily regarded as the most valid index of actual course content. Student reports, achievement test results, and content analysis of textbooks and lectures could be employed as alternative measures, which are perhaps more

objective. Nevertheless, since the instructors were to play a central role in curriculum development and instructional improvement subsequent to the study, their perceptions were deemed to be an appropriate focal point in the review process.

A questionnaire was developed, including the 72 skills compiled for the Taxonomy of Research Competencies. For each of the 72 skills listed, faculty members who teach a research course were asked to indicate:

1. Whether the skill was included in their course.
2. If included, whether the skill was given major emphasis, moderate emphasis, or minor emphasis.

The ratings for each skill in each course were summarized so that department and faculty advisor could make comparisons among research courses and recommend to students those courses that include the desired skills at the desired levels of emphasis. Additionally, the data about each skill were presented (a) to characterize each research course, (b) to compare the emphasis of different instructors who teach the same course, and (c) to portray the overall coverage of research in the curriculum.

Results

The emphasis which was reportedly placed on each skill was compared within and across courses (See Table 5). According to the faculty responses, almost every one of the 72 skills was taught with at least moderate emphasis in one or more courses. In fact, there were only two skills which were not given major emphasis in at least one of the 15 courses studied. Sixty-five percent of the skills were said to be given major emphasis in five or more courses, and 80 percent were claimed to be given moderate or major emphasis in five or more courses.

Interestingly, instructors in six of the 15 courses claimed to give moderate or major emphasis to over half of the 72 skills listed, and the results from two courses indicated a claim of moderate or major emphasis on over 75 percent of the 72 skills. The differences in the total number of skills said to be emphasized presumably reflect differing degrees of emphasis and concentration on particular skills. The faculty members who purportedly give major emphasis to 40 or 50 skills are presumably not providing as much depth or focus on each skill as the ones who claim to give major emphasis to only 10 or 15 skills in the same amount of instructional time.

Table 6 summarizes the extent of variability among instructors teaching particular research courses. These analyses revealed substantial disparities among instructors in several instances. In one course taught by six different faculty, there was a range of two or more levels (on a four level range) for 58 percent of the skills listed, and a range of from "not taught" to "major emphasis" on 25 percent of the skills. These data suggest that there may be a wide content disparities among different instructors teaching the same course.

Figure 1 compares the courses in terms of their relative emphasis on research skills within the four broad categories of research competencies. In addition to portraying a general profile for each course, the figures indicate that only one course gives primary emphasis to formulating a problem statement, and two focus on interpreting results. Six courses give main emphasis to designing and conducting the study and four to data analysis.

In summary, this study provided us with considerable data for describing the contents of existing courses, for comparing different instructors of the same course, and for comparing different courses. The findings were enlightening, in that they revealed considerable variability within courses. They also suggested that almost all of the skills under consideration were taught in one

course or another. However, most courses emphasized either design or data analysis, whereas only a few emphasized problem formulation or interpretation of the results. These findings suggested to us that certain courses should be standardized, and furthermore, that skills in problem formulation and interpretation of results needed to be given more emphasis for students in some programs.

I wish to add one note of caution in interpreting these results. Instructors' self-reports of instructional emphases should not be viewed as objective indices of either the extent or adequacy of instruction with respect to the skills in question. They should be regarded as the instructors' subjective judgments and attributions of their instructional practices and efforts. Two instructors may report they emphasized a given skill, yet they may differ in their specific foci, as well as the depth, breadth, and clarity of instruction. Additional information could be gained through other perspectives on instructional emphases, such as students; as well as through objective measures of students' knowledge and skill upon completing the course. Nevertheless, as stated previously, instructors' representations of their teaching practices do provide a practical and relevant vantage point for assessing the contents of an existing curriculum.

Table 1
Required Quantitative Methods Courses by Department and Degree

	<u>Quantitative Research Courses</u>																
	<u>EDF</u>	<u>EDP</u>						<u>EDT</u>				<u>EDA</u>					
<u>Department/Degree</u>	500	454	550	552	554	555	556	750	501	502	503	504	791	792	700	792A	792B
Counselor Education (CED)																	
PhD					X	X	X										
EdD																	
MED/MC	X	X		X													
Ed. Administration (EDA)																	
PhD	X	X		X												0	
EdD	X	X														0	0
MEd	X																
MA	X	X															
Ed. Psychology (EDP)																	
PhD			0	0	0	0			0	X							
MA			0		0												
MED			0		0						X		X				
Ed. Technology (EDT)																	
PhD		X		X	X				0	0	0	0	0	0	0		
EdD		X		X					0	0	0	0	0	0			
MED	X								0	0	0	0					
MA		X									0						
Elementary Education (EED)																	
PhD		X	X	X	X						X	X				X	
EdD		X		X													
MED	X	X															
MA	X	X			X												
Higher & Adult Ed. (HAED)																	
PhD		X		X	X				X		X	X					
EdD		X		X	X				X		X	X					
MED	X	X															
Secondary Ed. (SED/EDF)																	
PhD	0			X												X	
EdD	0			X												X	
MED/MA	0											X					
Special Education (SPE)																	
MA	X	X		X						X	X	X					
MED	X	X		X						X	X	X					

Note. X = interdepartmental requirement
0 = intradepartmental requirement

Table 2

Enrollment in Programs, Fall, 1978*

DEPARTMENT & PROGRAM	M.A.E.	M.A.	M.Ed.	M.C.	Ed.S.	Ed.D.	Ph.D.
Dept. of Counselor Ed.							
Counseling, (Masters)	93		21				
Counseling, (MC/EdS)				155	1		
Counseling Psych., (Doctoral)						3	42
Total = 315							
Dept. of Ed. Administration							
Ed. Administration, (Masters)	31	2	20				
Community Ed., (Masters)	6						
Ed. Administration, (EdS)					14		
Ed. Administration, (Doctoral)						42	22
Total = 137							
Dept. of Ed. Psychology							
Ed. Psychology, (Masters)	23	9	1				
School Psychology, (EdS)					5		
Ed. Psychology, (Doctoral)							25
Total = 63							
Dept. of Ed. Technology							
Ed. Technology, (Masters)	1		6				
Library Science, (Masters)	24						
Instructional Media, (Masters)	20						
Ed. Technology, (Doctoral)						5	18
Total = 74							
Dept. of Elementary Ed.							
Elementary Ed., (Masters)	249	7	14				
Reading, (Masters)	39						
Elementary Ed., (EdS)					2		
Elementary Ed., (Doctoral)						26	35
Total = 372							
Dept. of Higher/Adult Ed.							
Adult Ed., (Masters)	12						
Higher & Adult Ed., (Masters)			8				
Higher & Adult Ed., (EdS)					1		
Adult Ed., (EdS)					2		
Higher Ed., (Doctoral)							38
Adult Ed., (Doctoral)						13	34
Higher & Adult Ed., (Doctoral)							1
Total = 109							
Dept. of Special Ed.							
Special Ed., (Masters)	192	20	37				
Communication, (Masters)	1						
Indian Ed., (Masters)	7						
Total = 257							

*Data Provided by Office of Institutional Studies and Planning

Table 3a

Spring & Fall 1978 Enrollment in
Education Foundation Research Course
by Degree Program & Department

DEGREE & DEPARTMENT	500	
	S	F
MAE		
Counseling	10	8
Ed. Admin.	2	1
Community Ed.	2	2
Ed. Psych.	1	
Lib. Sci.	2	
Elemen. Ed.	33	14
Reading	6	5
Adult Ed.	1	1
Special Ed.	34	19
Indian Ed.	7	2
Sec. Ed.	4	7
Sec. Ed.-Soc/Phil Found	2	1
Sec. Ed.-Interdept.	12	4
MA		
Elem. Ed.		1
Special Ed.		2
MED		
Ed. Admin.		1
Special Ed.		1
Sec. Ed.		1
MC		
Counseling	11	9
EDS		
Ed. Admin.	1	
EDD		
Ed. Admin.	2	1
Adult Ed.	1	
Sec. Ed.		2
Curric. & Instr.	1	
Sec. Ed.- Interdept.		1
PHD		
Higher Ed.	2	1
Sec. Ed.	1	1
Non-Ed.	3	6
Unclassified	25	20

Grand Total = 163 111

Table 4
Spring and Fall Enrollment in Research Courses
by Department and Degree Program

Department:	434	530	532	EDP	534	535	536	500	501	EDT	503	504	Row
Courses:													Total
Semester:	S ^a	F ^b	S	F	S	F	S	F	S	F	S	F	
Department/Degree													
Elementary Education													
MAE	2		1	1				33	14				51
MA									1				1
MED	1												1
EDD	2	4		4	1	2							13
PHD	5		5	2	3		1	1		1	1	1	20
Educational Technology													
MAE	1											2	3
MED	1								1	1			3
EDD	1								1	1	2	2	7
PHD	3			1	1	1	1	1	6	3	6	4	27
Educational Psychology													
MAE	4	2	8	3		7	4	5	3	1		1	38
MA	3			1									4
EDS	1			1		1							3
PHD			3	2	1	2		1					9
Ed. Admin. & Super.													
MAE								2	1				3
MED									1				1
EDS								1					1
EDD	1	1		1				2	1				6
PHD		2		3	1							1	7
Non-education													
	7	18		4	4	3	3	3	6			1	49
Unclassified													
	21	17		5	6	4	2	1	25	20	5	1	109
Column Total	37	60	11	29	18	13	17	10	7	67	44	14	356

^aS - Spring

^bF - Fall

^c-- - Not Offered

Table 5
The Instructional Emphasis Placed on Research Skills
in Selected Quantitative Methods Courses

Research Skills	EDF 500	EDF 454	EDF 550	EDF 552	EDP 554	EDP 555	EDP 556	EDP 750	EDT 501	EDT 502	EDT 503	EDA 700	EDA 792A	EDA 792B
A. FORMULATING A STATEMENT OF THE PROBLEM														
1. RECOGNIZE AND APPRECIATE QUANTITATIVE INVESTIGATIONS AS AN EFFECTIVE WAY OF SOLVING THEORETICAL AND APPLIED PROBLEMS	11211	11	1	11	3	4	3	2	3	1	3	1	1	4
2. IDENTIFY UNRESOLVED ISSUES AND INFORMATION GAPS	11231	24	3	43	4	4	4	1	3	4	2	1	1	4
3. FOCUS ON SPECIFIED ISSUES AND QUESTIONS RAISED	11131	34	2	42	3	4	4	1	2	1	1	1	1	4
4. ANALYZE ENVIRONMENTAL CONTEXT TO EXPAND UNDERSTANDING OF THE PROBLEMS	21-21	34	3	42	3	4	4	1	4	3	2	3	3	4
5. REVIEW GENERAL RESEARCH AND THEORIES TO CLARIFY EXISTING KNOWLEDGE RELATED TO PROBLEMS	32231	44	1	41	4	4	4	1	3	4	1	1	1	4
6. REVIEW (CRITICALLY) SPECIFIC RESEARCH RELATED TO IDENTIFIED PROBLEMS	11121	44	1	42	4	4	4	1	3	4	2	3	2	4
7. USE GENERAL EVALUATION MODELS TO PLAN A STUDY PROCEDURE	41-11	44	1	34	4	4	4	4	1	1	4	2	2	4
8. USE GENERAL RESEARCH DESIGNS AND MODELS TO PLAN A STUDY PROCEDURE	11211	43	1	12	4	4	3	3	4	4	1	1	1	4
9. FORMULATE GENERAL QUESTIONS AND CONCEPTUAL HYPOTHESES BASED UPON THEORETICAL ANALYSIS AND LOGICAL ASSUMPTIONS	21111	43	1	31	3	3	2	1	4	2	2	1	1	1
10. FORMULATE SPECIFIC (TESTABLE) RESEARCH HYPOTHESES	21211	43	1	11	3	3	2	1	4	4	1	1	1	1
11. FORMULATE SPECIFIC (ANSWERABLE) EVALUATION QUESTIONS	12211	22	1	34	4	4	4	1	1	1	4	2	2	1
12. WRITE A RESEARCH PROPOSAL	23121	44	1	44	4	4	4	1	4	1	1	4	1	4
B. DESIGNING AND CONDUCTING THE STUDY														
1. DETERMINE AND DESCRIBE THE ENVIRONMENTAL SETTING FOR GIVEN RESEARCH	21111	24	2	42	3	4	4	3	4	3	2	3	3	4
2. ANALYZE SITUATIONAL VARIABLES RELATED TO INDUCEMENT OF TREATMENTS OR ASSESSMENTS	21111	33	1	42	3	4	4	1	1	3	2	1	1	4
3. DEFINE A POPULATION FOR RESEARCH	21111	13	1	11	3	3	3	4	1	3	1	1	1	2
4. DESIGN SAMPLING PROCEDURES FOR RESEARCH	21211	34	2	12	3	4	4	4	4	3	1	1	1	1

1 - Major Emphasis 2 - Moderate Emphasis 3 - Minor Emphasis 4 - Not Taught - = No Response

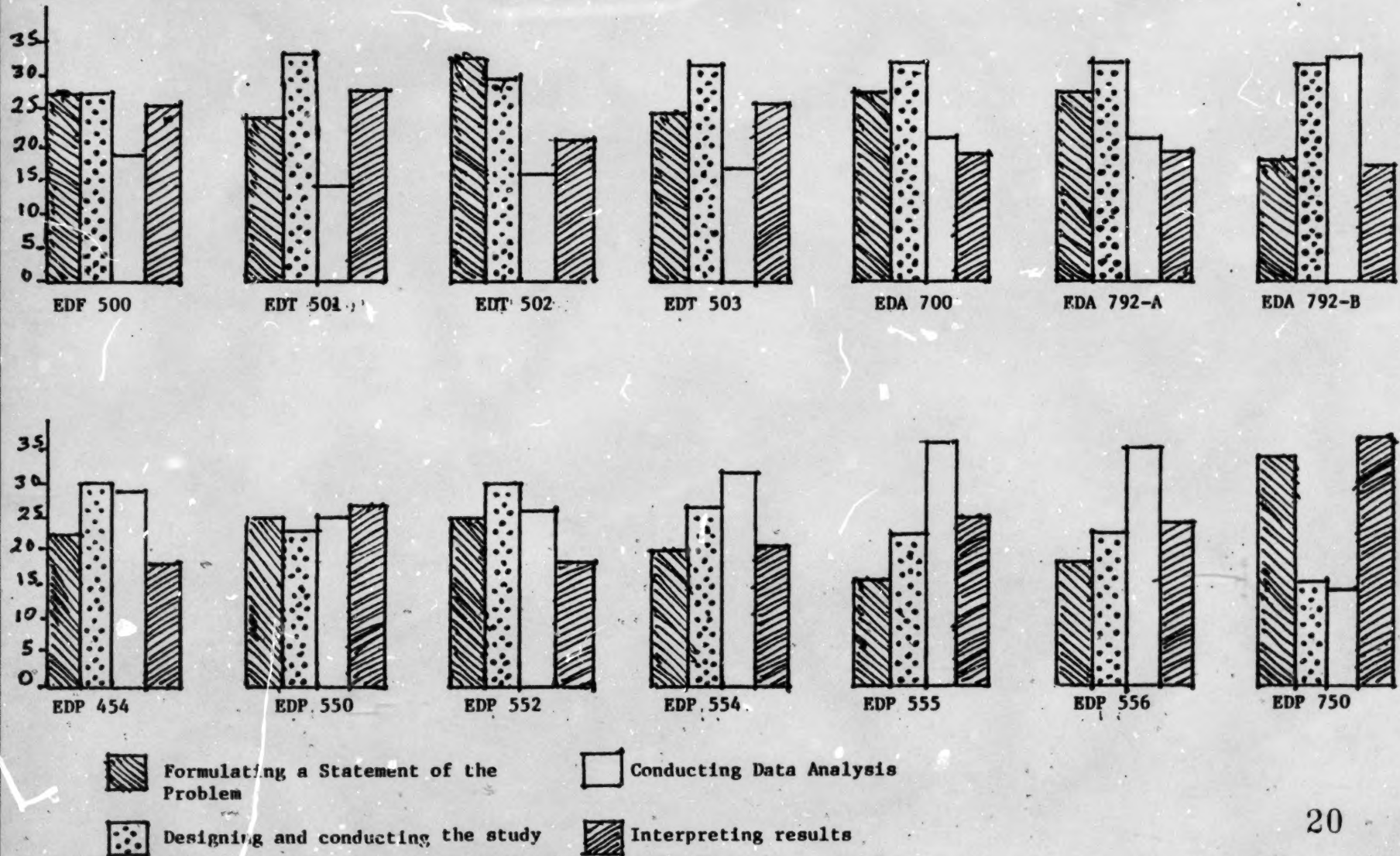
Table 6

Number and percent of skills with differential emphasis
(courses which have more than one instructor)

Range of differential emphasis	EDF 500		EDF 454		EDP 552	
	<u>N</u>	<u>%</u>	<u>N</u>	<u>%</u>	<u>N</u>	<u>%</u>
0	6	8	36	50	33	46
1	21	29	23	32	23	32
2	26	36	10	14	14	20
3	19	26	3	4	1	1
Total number of skills	72		72		71	

Figure 1

Proportionate emphasis reported in each
skill area of research courses



Appendix A
Arizona State University
Taxonomy of Research Skills

A. Formulating a Statement of the Problem

1. Recognize and appreciate quantitative investigations as an effective way of solving theoretical and applied problems.
2. Identify unresolved issues and information gaps.
3. Focus on specified issues and questions raised.
4. Analyze environmental context to expand understanding of the problems.
5. Review general research and theories to clarify existing knowledge related to problems.
6. Review (critically) specific research related to identified problems.
7. Use general evaluation models to plan a study procedure.
8. Use general research designs and models to plan a study procedure.
9. Formulate general questions and conceptual hypotheses based upon theoretical analysis and logical assumptions.
10. Formulate specific (testable) research hypotheses.
11. Formulate specific (answerable) evaluation questions.
12. Write a research proposal.

B. Designing and Conducting the Study

1. Determine and describe the environmental setting for given research.
2. Analyze situational variables related to inducement of treatments or assessments.
3. Define a population for research.
4. Design sampling procedures for research.
5. Select or identify relevant variables, (e.g., environmental, individual difference, treatment, dependent extraneous variables, etc.) for research.
6. Develop treatment procedures: Develop/adapt materials and/or conditions required for each treatment (includes pilot testing and revision).
7. Develop procedures for describing and/or measuring relevant extraneous and dependent variables.

B. Designing and Conducting the Study (cont'd.)

8. Determine when measurement/observations of identified variables (performance attitudes, and/or perceptions) should occur during treatments (i.e., pre/post).
9. Determine which measurement/observation formats are most appropriate.
10. Select or develop measurement or observation procedures for each variable in studies.
11. Develop instruments, directions, and scoring procedures (includes pilot testing and revision).
 - A. State arguments on both sides of current methodological issues for norm-referenced and criterion-referenced scoring.
12. Establish the reliability and validity of intended measures.
13. Apply procedures for examining or controlling extraneous variables, (i.e., randomization procedures, replication techniques, population restrictions, blocking, statistical control, etc.)
14. Select appropriate descriptive statistics (indexes of control, tendency, variability, association, frequency distributions, proportions, etc.)
15. Select appropriate inferential statistics and/or analysis procedures.
 - A. Review advantages and disadvantages of alternative possibilities, (e.g., various non-parametric and parametric techniques, ethnographic techniques, etc.).
 - B. Identify assumptions and effects of not meeting assumptions for any type of analysis procedure.
 - C. Select a design which is feasible for the situation and statistically efficient.
 - D. Formulate appropriate model for data analysis, (e.g., linear, non-linear, discrepancy analysis, etc.).
 - E. Select general and special contrasts to match hypotheses or research questions.
16. Integrate all aspects of a problem and design a study.
17. Determine and describe procedures for conducting the research.
18. Collect data.

C. Conducting data analysis/interpretation

1. Read and use scientific notation to describe hypotheses and statistical techniques.

C. Conducting data analysis/interpretation, (cont'd)

2. Plot data distribution (univariate and bivariate).
3. Calculate descriptive statistics, (e.g., measures of location, variability, association, skewness, kurtosis, etc.).
4. Calculate position in a distribution (e.g., standard scores, percentile ranks, omega values, etc.).
5. Apply logic of appropriate inferential techniques for statistical comparisons
 - A. Classical Hypotheses testing:
 - 1) Formulating null or other statistical hypotheses
 - 2) Select appropriate significance level
 - 3) Identify proper power curve or effect size
 - B. Use Bayesian procedures
 - C. Use statistical power analysis procedures
 - D. Set confidence intervals
6. Calculate:
 - A. Tests of group differences (univariate and multivariate)
 - B. Tests of relationship (bivariate and multivariate)
 - C. Tests involved in development of prediction systems
 - D. Nonparametric techniques
 - E. Hypotheses generation techniques, (e.g., factor analysis, etc.)
 - F. Psychometric scaling procedures, (e.g., Guttman scaling)
 - G. Measurement instrument analysis, (e.g., item analysis, content analysis, ispative and abative forms of norming, Rash model approach, etc.).
7. Prepare data for computer analysis (coding, keypunching)
8. Use prepared computer packages to analyze data (e.g., SPSS, BMD, Multivariate, etc.)
9. Program data analysis techniques using a computer language (Fortran, Cobol, etc.)

D. Interpreting Results and Disseminating Information

1. Design data summary displays to facilitate interpretation
2. Interpret data from:
 - A. Data charts or summaries
 - B. Computer output
3. Analyze, interpret and generalize results as they relate to real world conditions, study conditions, previous research, and specified hypotheses.
 - A. Formulate and write statements which express the relationship between the analysis of results and the hypotheses or questions raised.
 - B. Formulate and write implications of results for practical applications that are warranted by results.
 - C. Relate results to previous research findings.
 - D. Formulate and write statements of implications of results for current theories.
4. Determine journals, newsletters, meetings, conferences most appropriate to a study.
5. Identify sources of information to determine publication/presentation styles, policies, procedures, guidelines and criteria and use appropriate sources.
6. Organize, draft and revise the manuscript/paper for the journal/conference/organization based upon specified style.
7. Edit manuscripts for clarity, style, organization, etc.
8. Critique and review manuscripts to assess quality and contribution
9. Abstract and summarize studies.
10. Synthesize body of research related to a practice or problem.